

DOCUMENT RESUME

ED 252 826

CS 007 896

AUTHOR Gerhard, Christian
TITLE Reading and Technology: Tangibles and Intangibles.
PUB DATE Jul 84
NOTE 34p.; Paper presented at the Annual Conference of the United Kingdom Reading Association (21st, Dundee, Scotland, July 23-27, 1984).
PUB TYPE Viewpoints (120) -- Speeches/Conference Papers (150)
EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Cognitive Processes; Communication (Thought Transfer); *Computer Assisted Instruction; Economic Development; *Educational Needs; Literacy; Political Power; *Reading Instruction; *Reading Processes; *Social Change; *Technological Advancement; Visual Stimuli

ABSTRACT

Several aspects of the relationship between reading and technology are presented that have special relevance to those individuals who feel responsible for aspects of contemporary education. Five main points are covered: (1) technological innovations as they affect reading are essentially extensions of the sensory and kinesthetic abilities of human beings; (2) reading during any historic period reflects a society's goals and values and therefore a particular use of language; (3) formal education is an important part of the political and economic structure of a society, giving access to power, and affected by technological change--the teaching of reading is at the heart of any formal education; (4) those who teach reading need a broad general education in order to understand the goals and values of their society, the technological changes that are taking place leading to changes in ways of thinking, the role of language in the larger culture and its subcultures, and the previous experience to which students have been exposed; and (5) teachers have a different set of experiences from their students (largely because of technological changes taking place from one generation to the next), yet teachers need to be flexible enough to understand their students' needs, aspirations, and world views. (DRB)

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

ED252826

George Washington University
Washington, D.C.

Christian Gerhard
6505 Cardigan Road
Bethesda, Maryland 20817

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

X This document has been reproduced as
received from the person or organization
originating it.
Minor changes have been made to improve
reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Reading and Technology:
Tangibles and Intangibles

Paper presented at the 21st Annual Conference of the
United Kingdom Reading Association in Dundee, Scotland,
July 1984.

"PERMISSION TO REPRODUCE THIS
MATERIAL IN MICROFICHE ONLY
HAS BEEN GRANTED BY

Christian Gerhard

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

CS007896

READING AND TECHNOLOGY: TANGIBLES AND INTANGIBLES

Introduction

The and of the title should be replaced by a symbol such as  to convey the degree of interaction between these two areas. The relationship is extremely complex and this paper can only attempt to introduce a few points of special relevance to those who feel responsible for aspects of contemporary education. The history of the relationship alone could fill volumes.¹ Space here prohibits any detailed account. A highly selective list of interesting events and suggested reading is provided at the end of the paper, all of it limited to our Western tradition.

The paper will attempt to introduce five main points.

(1) Technological innovations as they affect reading are essentially extensions of the sensory and kinesthetic abilities of human beings. By tracing the stages of technological developments, we can better understand in what way they are related to people and their ways of thinking.

(2) Reading during any historical period reflects a society's goals and values and therefore a particular use of language. Even technological innovations affecting reading occur, or are successful, as they relate to current goals and values.

¹The forthcoming Studies in the History of Reading, G. Brooks and A.K. Pugh (Eds), University of Reading School of Education, will be a welcome addition.

(3) Formal education is an important part of the political and economic structure of a society, giving access to power, and affected by technological change. The teaching of reading and particular use of language is at the heart of any formal education.

(4) Those who teach reading need a broad general education in order to understand a) the goals and values of their society, b) the technological changes that are taking place leading to changes in ways of thinking, c) the role of language in the larger culture and its subcultures, and d) the previous experience to which students have been exposed.

(5) Largely because of technological changes taking place from one generation to the next, teachers have had a different set of experiences from their students. Nevertheless, they need to be sufficiently flexible to understand their students needs and aspirations and the way the world looks to them. This is because no learning can take place unless new information is incorporated into old. The new information may require developing new kinds of perception, or expectation, but these must also be linked to previous modes.

TECHNOLOGICAL INNOVATIONS AS EXTENSIONS OF HUMAN CAPABILITIES

The first main point, that technological innovations are essentially extensions of sensory and kinesthetic abilities of human beings, is especially important in establishing a

human framework for the new technology. Nobody has described it better as it relates to changes in thinking than Jerome Bruner. In an article entitled "Growth of Mind" (1965), he says, "The evidence today is that the full evolution of intelligence came as a result of bipedalism and tool using (p.437)." Without the development of tools, the large human brain would not have compensated for physical vulnerability. Primitive extensions of the hands with stone tools fashioned by individuals evolved slowly into cultural transmission of tool making and tool mastery. Language became an important part of this transmission. Unlike ape societies, young humans spend most of their time with adults who instruct and guide them in survival and in the mores of the tribe. Gradually, as the tribe grows, there is more knowledge within the social group than can be mastered by one person and teaching of the young becomes a specialized activity divorced from the experiences and tasks of daily life.

Bruner writes:

This very extirpation makes learning become an act in itself, freed from the immediate ends of action, preparing the learner for the chain of reckoning remote from pay-off that is needed for the formulation of complex ideas. (p.1009)

At the time Bruner wrote this, he had cross-cultural evidence that schooling itself made a profound difference in thinking processes (1966). Since that time there has been much additional evidence, such as the work of Scribner and Cole (1981).

The dialogue between teacher and student which originated as part of tool making and mastery instruction appears to be at least as telling as the process of learning to read and write itself. Language when written is used abstractly, "freed from the immediate ends of actions," and requires direction in how to approach it. This is especially the case with the phonetic alphabet, as compared to others, for meaning is abstracted from sound and then translated into a symbolic, visual code. As Marshall McLuhan wrote in The Gutenberg Galaxy (1962), a new way of perceiving the world evolved from the shift in perceptual weight from ear to eye; from listening to reading. At the same time, the written word "detribalized" people by creating private, individual thinking space for interaction with language.

The stages of development can be traced in capsule form. Illiterate mankind might be said to have lived in a world vibrant with sound and shared experience, where thought and action were intimately related, time and space varied with geography, the seasons, and the weather, and art was part of the magical explanation of cause and effect illustrated by means of sacred objects.

Literate mankind, on the other hand, has learned detached habits of observation based on analysis of data unrelated to direct action, regards time and space from a fixed point of view determined by instruments, and looks at pictures as representations rather than as objects with magical significance.

Electronic mankind will learn to live with systems of symbolic abstraction one remove further from daily life than literate man. Languages with little connection to the mother tongue or to daily life will probably be learned (Ong, 1977), at least until 5th or 6th generation computers using natural language are common. Written communication will be via machines capable of computing and transmitting information in seconds which was formerly slaved over by skilled people for weeks. Detached habits of observation will be mostly achieved by remote control and will include many systems for classifying and encoding information about process and content, as well as about storage and retrieval. Decoding these systems will mean taking many constraints into account.

While literate man is dependent on technological developments such as a good light, a pair of spectacles, a printing press whose ancestor was the Roman wine press, paper, and ink, electronic man will be dependent on reliable sources of power, a machine complete with technician to repair it, complex books of instructions, and the ability to manipulate the machine in a reasonably efficient manner. Mukerji, writing in From Graven Images: Patterns of Modern Materialism (1983), speaks of our Western societies classifying our material goods under the label Economy, while it is our culture which is now built around our patterns of consumption. We are what we own.

All of these changes in symbols and technology are reflected in reading patterns and attitudes. Medieval and early Renaissance

readers wished to share in the wisdom and comfort of the Bible. Before the printing of the Gutenberg Bible in 1456, manuscripts were objects of veneration in themselves and when the book was the Bible, it partook of some of the magic which writing tends to dispel. In some societies this still holds true, but a utilitarian approach is far more typical. Most of text read today is consumable, not even reaching a library shelf, and concerns the needs of the day.

Reading Reflects a Society's Goals and Values

The undeniable truth that there has been a basic change in attitudes toward reading since the Middle Ages serves to introduce the second point of this paper: that reading during any historical period reflects a society's goals and values and therefore a particular use of language. At the time of the Latin Gutenberg Bible, 1456, the Renaissance was in full swing, Leonardo da Vinci was a young boy, perspective painting, empirical science, and advances in mathematics were on their way, but most of the populace of Europe followed the dictates of the Church, either out of conviction, inertia, or fear. Life in the next world was very close with life expectancy in the thirties, and real comfort could be derived from believing in rewards in that life since there were few in this. Although there was a growing class of educated people, even outside the church and the universities, these institutions were guardians of the manuscripts

and source of scribes to copy them. Schooling was in Latin, excluding all but a few, but on the other hand making it possible for those who knew it to correspond with scholars all over Europe.

With the revival of classical learning there was an increasing audience interested in reading about the classical past, the political and religious present, and the scientific future. Advances in the latter were rapid. Copernicus was born less than a generation after the Gutenberg Bible appeared. A system for distributing new information had already been established before that date.

While the Church remained very powerful, the corruption and dissension, the period of the two popes, made it easy for people to question the right of its leaders to dictate all aspects of life. Once Luther nailed his ninety-five theses to the door in Wittenberg in 1517, the floodgates of doubt were opened (Small, 1982).

The stage was therefore set for the second great revolution in communication history after the invention of writing: the advent of printing. The Gutenberg Bible and Psalter were printed on six presses simultaneously and represent the first use of movable, interchangeable parts and mass production with an assembly line procedure. It is estimated that within less than fifty years, over fifteen million volumes were produced by nearly two thousand presses all over Europe except Russia. By 1530 there

was a press in Mexico.

The production of multiple copies of a work meant that news traveled fast, that preservation was easier and censorship less effective, although it was first tried in England early in the sixteenth century and has been used frequently since. Within a decade after Luther's bold act, hundreds of thousands of copies of his writings were circulated all over Europe, making the reform movement widely known in a very short time. Within this period books were also published in pocket book size and in the vernacular.

The goals and values of sixteenth and seventeenth century society were revealed in other ways, such as a new interest in developing systems for better organizing the information which was becoming important not only for the intellectuals, but also for the commercial groups. Until the seventeenth century alphabetizing was little used, although it had been in the Alexandria Library. Gradually new systems of codifying and classifying material developed, aided by a sharp reduction in the price of paper. Encyclopedia became popular, followed by dictionaries, and by the middle of the seventeenth century scholarly journals were circulating.

The printing of books brought about other changes in society. Schooling became available to the new commercial classes, and, although the main subject was still Latin, mathematics and rhetoric also received attention. Reading was often first taught

in the vernacular by means of spelling books.

Many new trades and professions developed and the people in them had greater access to power. Publishers were often among the best-educated people of their day with whom writers associated and consulted. Some of them fell victim to the Inquisition. Skilled printers, paper manufacturers and distributors, book designers and book sellers became important. Webster's speller, published in 1793, sold fourteen million copies by 1843 (Monaghan, 1983). Musicians churned out popular ballads, and writers like Defoe set out to make money by writing books. Agents became active all over Europe, ferreting out all kinds of information such as financial news for Fugger's newsletter, or reporting the political news for the London and Edinburgh Gazettes, both started in the 1660's. In 1702 the first daily newspaper was published in London and seven years later there were nineteen papers in London alone, feeding the information needs of increasing numbers of readers and capitalizing on the shifts in society.

All of these developments in these two and a half centuries since printing began meant a great upheaval in society in general. Rabelais put it vividly not long after that event.

I see robbers, hangmen, free-booters, tapsters, ostlers, and such like, of the very rubbish of the people, more learned now than the doctors and preachers were in my time. What shall I say? The very women and children have aspired to this praise and celestial Manna of good learning. (Quoted by McLuhan, 1962, p.147).

The shifts in society reached a new height by the end of the eighteenth century with the American and French Revolutions.

Both of these depended heavily on the printing press. Perhaps more important in terms of modern technological development were the accomplishments of Pascal, Newton, Leibnitz and Euler. They changed the way people looked at future events and ranked them, perceived light waves, saw the relationship between all matter, and discussed the theory of numbers. Boundaries of the European world also expanded with improved navigation and the colonial annexation of the New World and India.

The nineteenth century and the first decade of the twentieth saw the groundwork laid for information technology. Electricity was rapidly harnessed after Edison invented the light bulb in 1879, making many new kinds of what Bruner calls sensory extensions possible as well as an accelerated pace of scientific innovation. The study of eye movements while reading was one of these, leading to the publication of Huey's book on reading in 1908.

Mass publication of inexpensive books became common in the nineteenth century and specialized markets for romances or adventure stories were encouraged (Stern, 1980, Bonn, 1982). In business as in science, information became more and more valuable and the demand for ever faster transmission was not stilled by the invention of the telegraph, the telephone, and the typewriter. With the industrial revolution in full swing, governments became involved in promoting and regulating nationwide systems such as the post office which required more data. While punched cards had already been used with some textile machinery, they were first used for

government data collection in the United States census of 1890. A few years later the radio telephone was operating across the Atlantic and the electron tube was developed. Time and space had telescoped.

Computers and calculators of various kinds were built in the 1940's and by 1948 transistor devices were made. A year later Shannon published The Mathematical Theory of Communication. The electronic age had begun. Not only did reading matter change, but the way it was stored and retrieved underwent equally great changes. In 1950 librarians joined mathematicians, psychologists, and linguists in documenting information processing procedures and uses, and the profession of being a librarian was altered in countless ways (Kent and Galvin, 1982, Mechler, 1982). Reading now reflects society's mad scramble for the latest information, and that is seen as access to power.

The harnessing of electricity and modern concepts of binary numbers were combined to produce a new means of coding information. The concepts of this combination have not only been important for encoding language, but for an understanding of all forms of encoding, including genetic. Information itself, in the new era, is defined as a reduction of uncertainty, and signals are all kinds of communications which reduce uncertainty. Natural processes such as the growth of corn or the birth of a baby are now seen by scientists as exchanges of information as well as biological processes (Ritchie, 1984). Information within the theory is not seen as

synonymous with the traditional concept of meaning and the word is misleading (Sloman, 1978). Its value in the theory lies in the degree of uncertainty which precedes its reception - the greater the uncertainty, the greater the value of the information. Through Shannon's work and that of others, laws governing English text were elaborated and letter and word frequencies established. Figure 1 is an example from Pierce's book, Symbols, Signals and Noise: The Nature and Process of Communication, written in the early electronic period, 1961.

(Figure 1)

Reading in the electronic age, then, includes many varieties of encoding, decoding, and retrieval systems (Oddy et al., 1981). The phonetic alphabet is only one of these. Neurophysiologists read brain scans, cardiologists read electrocardiograms, stock brokers read the Dow Jones report, now a century old, and sports addicts read the statistics of athletes. There are "how to" books on everything from plumbing to meditation. Computers can draw maps from different angles and there are maps of the ocean floor. There is only one glaring problem: if people have not learned any of the coding systems, they cannot avail themselves of any of these delights. The goals and values of our society are reflected in tremendous disparity between those who can enjoy the fruits of the technological developments since the the Gutenberg Bible and those left with the pits.

Figure 1

<i>Word</i>	<i>Probability p</i>	<i>Code</i>	<i>Number of Digits in Code, N</i>	<i>Np</i>
the	.50	1	1	.50
man	.15	001	3	.45
to	.12	011	3	.36
runs	.10	010	3	.30
house	.04	00011	5	.20
likes	.04	00010	5	.20
horse	.03	00001	5	.15
sells	.02	00000	5	.10
				<u>2.26</u>

Pierce, J.R. Symbols, Signals and Noise: The Nature and Process of Communication, New York, Harper, 1961

The Teaching of Reading is at the Heart of Formal Education:
The Means of Access to Political and Economic Power

Consideration of the disparity between those who can gain access to political and economic power through formal education and those who cannot is especially important for those who control the acquisition of symbolic code knowledge, which is at the heart of formal education. For, in spite of prophecies that traditional reading is a thing of the past, learning how to interpret a symbol system and the formal language which goes with it, and dealing with the "decontextualized" nature of written language (Olson, 1977, Stubbs, 1980, Martlew, 1983) is the modern equivalent of a working knowledge of Latin in the Renaissance. However, changes in emphasis in the teaching of reading are made necessary by the new technology and consequent changes in perception of society, the world, and the space around it. These perceptions, determined by our knowledge of and beliefs about the world, lead to mental representations of events which must then be related to words in order to communicate with others (Schank, 1982).

A few speculations about the kinds of changes that may be necessary in the teaching of reading in order to empower more elements of our society in the electronic age follow.

One of the changes is surely a renewed emphasis on probability thinking. Information theory assigns value to items of information by establishing how predictable they are; or the probability that they would occur. Artificial intelligence scholars, attempting

to simulate human thought on the computer, have worked with this problem and with how much prior knowledge is necessary in order to increase the probability of predicting events, or making inferences. In studies of novices and experts, the latter have been proven far more able to make predictions and inferences by virtue of their internalized knowledge of a subject, which includes knowledge of the vocabulary or concepts, but also the possibilities or constraints within a particular structure of ideas (Greeno, 1980, Waldrop, 1984). While the emphasis at the beginning of the electronic age was on process, the knowledge of and experience with a certain area is now seen as central to comprehension. Knowledge is used in "problem spaces" which include a variety of possible behaviors to be sorted out by search control knowledge acquired through past experience (Newell, 1980). The evidence points strongly to the need for instruction in probabilistic thinking based on specific facts and a familiarity with the structure of ideas related to those facts. A trained musician, familiar with the rules of classical music, knows that a dominant chord at the end of a sequence is likely to be followed by a tonic unless transition to another sequence is called for. In the thoroughbass period it was only necessary to write coded numbers below a melody. It seems quite clear that an endless series of true and false or multiple choice questions related to a text will never improve student ability to think about probabilities and possibilities. Teacher/student dialogue is essential.

The structure of ideas within a particular field of knowledge is of course revealed by the language. Terry Winograd in Language as a Cognitive Process, Volume I (1983) provides a masterful summary of the different ways in which the structure of language has been approached historically, reflecting the goals and values of each recent period. The point to be made here is that for each kind of information a special language is necessary prior knowledge for reading comprehension to take place. This necessary language includes cues as to the function of particular portions of text and to the special structure of ideas (Binkley, 1983).

Many of ^{the} cues to structure are of a visual nature (Gerhard, 1984) which is fortunate, since most people are able to see them and could be trained in what to look for. The visual form of text has undergone great transformations over the years, reflecting technological advances and changing the educational scene. Before printing, text was often beautifully illuminated, its function being to present it so that each word would be important and the reader would have visual pleasure in the whole page. While there are still publishing companies which produce books with this in mind, the more common forms read today are newspaper columns, comics, advertisements, and a bewildering assortment of graphs, charts and models, as well as computer printouts of various kinds. A great deal of experience with and knowledge about the form and the visual cues to the form of these various ways of communicating information in print

is needed for their comprehension. This seems to indicate necessary changes in the way goals are set up for students learning to read expository text and related forms. Something like search control knowledge should be emphasized, leading to the ability to predict where to look on a page for certain kinds of information. Visual training in shapes and configurations should not end with decoding instruction.

In expository text, but even more in the computer world, one structure of ideas to be revealed by visual search which is both basic and highly problematic is the category. Commands for both encoding and decoding on the computer require the assigning of information to a named class or category. While it is possible to memorize a limited number of procedures without understanding them, ultimately the reader must be aware of how the information is grouped. In top-down processing, category labels are given and accepted and subsequent information is grouped under them, or is seen as so grouped. In bottom-up processing, on the other hand, items of information are perceived first and are then seen to be related in different ways. The following two figures, to be read in the direction of the arrows, attempt to demonstrate these two ways of processing, as well as the relationship of these terms to the older ones of deduction and induction, and the Piagetian terms assimilation and accommodation.

(Figures 2 and 3)

Figure 2

↓
DEDUCTION PROCESSING FROM GENERALIZATION TO SPECIFIC ITEMS
ASSIMILATION - ADDING ITEMS TO AN EXISTING CATEGORY(STRUCTURE)

TOP-DOWN PROCESSING

(A PASSAGE FROM A BOOK ON COMPUTER OPERATIONS)

SOME NEW WAYS OF USING OLD WORDS IN COMPUTER OPERATIONS

↓
BREADBOARD: AN EARLY ARRANGEMENT OF A NEW ELECTRONIC
CIRCUIT SO THAT IT CAN BE MODIFIED EASILY

BUG AND DE-BUG: SOMETHING IS WRONG WITH THE SYSTEM
AND NEEDS TO BE PUT RIGHT

MENU: A DISPLAY ON A SCREEN OF VARIOUS OPTIONS FOR ACTION

↓
GRACEFUL DEGRADATION: SOMETHING HAS GONE WRONG, BUT THE
COMPUTER MANAGES TO PERFORM SOME
OPERATIONS

DEADLY EMBRACE: ALL PROCESSES IN THE COMPUTER COMPETE
FOR THE SAME RESOURCES AND EVERYTHING JAMS.

REFERENCE: SMITH AND CAMPBELL, INFORMATION TECHNOLOGY
REVOLUTION, LONGMAN'S, 1981.

Figure 3

("IT SEEMS TO BE A CASE OF SOME NEW WAYS OF USING OLD WORDS
IN SOME KIND OF COMMUNICATION SYSTEM.")

DEADLY EMBRACE AS IN THE SENTENCE " JUST WHEN I WAS
FINISHING THE JOB, THERE WAS A DEADLY
EMBRACE."

GRACEFUL DEGRADATION AS IN THE SENTENCE " NO, THE SYSTEM
WAS NOT DOWN COMPLETELY, BUT GRACEFUL
DEGRADATION HAD SET IN."

("THIS PAGE SEEMS TO BE ABOUT SOME KIND OF COMMUNICATION
SO THESE WORDS HAVE SOMETHING TO DO WITH INFORMATION
TRANSMISSION.")

MENU AS IN THE SENTENCE "FOR SOME REASON THE MENU DID
NOT INCLUDE SEARCH."

("THERE MUST BE SOME REASON FOR USING THESE WORDS IN SUCH
A PECULIAR WAY. I WONDER WHAT THIS IS ABOUT.")

BUG AS IN THE SENTENCE " I DECIDED NOT TO BUY IGLOO
BECAUSE I HEARD THAT IT HAD TOO MANY BUGS."

BREADBOARD AS IN THE SENTENCE "LUCKILY WE COULD CHANGE
IT BECAUSE WE WERE STILL AT THE BREADBOARD
STAGE."

(A PASSAGE FROM THE REMAINS OF A MAGAZINE FOUND IN THE
DENTIST'S WAITING ROOM)

BOTTOM-UP PROCESSING

ACCOMODATION - FORMING A NEW, THOUGH RELATED CATEGORY

INDUCTION - STARTING FROM SINGLE ITEMS, FINDING SIMILARITIES,
AND MOVING TOWARDS A GENERALIZATION EXPRESSING
A RELATIONSHIP BETWEEN THEM

These two systems for processing language are given modern names, but they have been discussed since at least the time of Aristotle. They are significant in relation to the structure of society in that deductive thinking requires faith in some authority to correctly assign category labels, while induction makes enormous demands of the individual to make decisions alone, and implies faith in the ability of people to do this. Historically, formal rules for inductive thinking are very new and justification for individual empirical decisions is still a topic of controversy in philosophy (Luckenback, 1972).

The ability to do bottom-up, inductive thinking is an important way of gaining access to power today. This way of processing information and its accompanying language grew out of the empirical sciences but spread to most fields, not least that of business management. The interpretation of a variety of facts in any area requires analyzing similarities and differences between them, and the use of appropriate generalizations expressing the perceived relationship. This is also true of computer analysis, except that the rules for attributes have to be rigidly prescribed and do not allow for borderline cases (Sloman, 1978).

Four aspects of inductive thinking are especially relevant to a discussion of possible ways in which the emphasis within reading instruction needs to be changed in order to better train students for the electronic age. There is first the observational aspect. This requires people to hold their normal expectations, or mind set,

in abeyance for the purpose of perceiving as objectively as possible. In science and the social sciences this often involves measurement or evaluation of various kinds. The purpose is to try to predict the probability of an item of information, or an outcome, given a certain pattern of relationships; or projecting from the known to the unknown. Estimating the probability of an outcome is the second aspect of inductive thinking and is directly related to mathematical concepts, as is so much contemporary processing. To totally separate language from these concepts during instruction, or associate mathematics exclusively with numbers, is not good preparation for the electronic age.

The third aspect of inductive thinking important to education is that for over a generation the total environment of a situation has been seen to affect any one item of information and its relationship to others, so that variables can no longer be legitimately ignored in favour of clean statements or research designs. Instead thinking needs to be holistic and evaluation often qualitative. This state of affairs has been arrived at because so many conclusions have been drawn which did not take the complexities of a situation into account and turned out to be erroneous, or because the time span used was far too short. This would seem to point to the need for more in-depth reading in the classroom, accompanied by analysis of all the elements affecting the subject matter; in a word, a more integrated approach to school subjects reflecting the changes in the real world.

Finally, if hypotheses are stated before a set of observations is made, may not the desire to prove or disprove them corrupt observation? This has certainly at times been the case. The dilemma arises when certainty rather than probability is the expected outcome(Nagel, 1955). While learning to frame hypotheses as a basis for investigating a topic is certainly useful, problem solving often requires seeing information in many different ways and different combinations, or flexibly. The ability to do this is crucial for innovative thinking.

All four aspects of inductive thinking discussed above require that educational systems provide a great deal of practice in individual processing of information; observing, making comparisons, and coming to appropriately phrased conclusions. These attempts should then not be judged necessarily right or wrong, but rather be the subject of discussion. It may be that our society comes to the conclusion that inductive thinking is not what is wanted of its citizens. In that case, piecemeal stabs at problem solving in the upper grades without any training in the lower grades should be abandoned in favour of sound deductive instruction. However, the disparity in access to power would inevitably widen.

Those who Teach Reading Need a Broad General Education

The fourth point of this paper follows from the rest: those who teach reading need a broad general education in order

to understand their society, the technological changes taking place which result in changes of perception and thinking processes, the role of language in all this, and the previous language experience and other experience to which students have been exposed, however limited it may be. Since learning consists of incorporating new information into existing frameworks while gradually altering and expanding these, nothing is to be gained by ignoring the reality of student prior experience. The broad general education is especially needed if inductive thinking is to be encouraged. Teachers must be able to consider whether conclusions drawn by students follow logically from their observations, and whether they are couched in accurate and appropriate language. The large demands made by bottom-up, inductive processing require a very systematic way of approaching it and of making decisions.

The way in which teachers can help prepare their students for the more formal aspects of making decisions is indicated by the following example from daily life taken from a recent book by Hurley on software decision making. The problem is to decide which coat to take to work or school in the morning. Here is the text version of the problem.

(Figure 4)

Even in text form, the thinking process is set up for maximum clarity. What are the conditions, the possible actions, and the values of those actions? In matrix form the problem is even

Figure 4

EXAMPLE FROM DAILY LIFE

IS IT RAINING AND COLD?

CONDITIONS: IS IT RAINING? (TESTS FOR THE CONDITION)
IS IT COLD?

ACTIONS: WEAR LINED RAINCOAT (THREE POSSIBLE AND
WEAR UNLINED RAINCOAT MUTUALLY EXCLUSIVE
WEAR WOOL OVERCOAT ACTIONS)

TWO VALUES: YES
NO

EXIT: PROCEED TO GARAGE

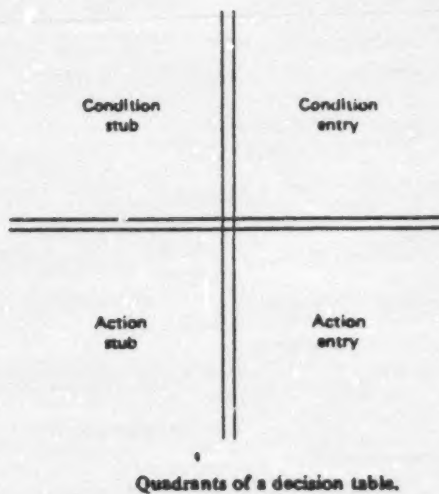
REFERENCE: HURLEY, DECISION TABLES IN SOFTWARE ENGINEERING,
VAN NOSTRAND REINHOLD DATA PROCESSING SERIES, 1983, p.10

clearer, once the system is understood and the rules for making the decision, such as "If it is both cold and raining, I shall take my lined raincoat," are formulated.

(Figure 5)

Seen in the light of an example from daily life, perhaps the idea of teaching to prepare students for the electronic age is less frightening and more related to the age of literate man than we thought. For children do work out probabilities of being punished for disobeying rules, they are able to talk about conditions for having a successful birthday party, the possible actions involved, and the rules to be made. They are also able to understand that a table has a certain form because of its function, that the manner in which a message or invitation is conveyed can affect the way it is received, and that there are limitations or constraints on the party due to space, time, and budgetary considerations. They know that the total environment can play a part in such ways as an outbreak of chickenpox, a storm, or a transportation strike. Finally, children know about classifying the guests in such ways as (1) those one wants to invite, (2) those one has to invite, (3) those who will bring delightful presents, or (4) those who will bring the discarded presents from their own party. Here are all the elements of decision-making and many of information processing ready to be built upon. Discussion of all of them will give opportunities

Figure 5



COAT TABLE		R1	R2	R3
C1	RAINING	Y	Y	N
C2	COLD	Y	N	Y
A1	WEAR LINED RAINCOAT	X		
A2	WEAR UNLINED RAINCOAT		X	
A3	WEAR WOOL OVERCOAT			X

Initial COAT TABLE showing the form of a decision table for some conditions, actions, and rules.

Hurley, R.B. Decision Tables in Software Engineering, New York, Van Nostrand, 1983, p.7-8.

BEST COPY AVAILABLE

to also build up the necessary language, provided sufficient practice is allowed.

Teachers need to Recognize and Accept Differences Between
Their Experience and that of their Students

Our final point is that teachers in all ages have grown up under different historical conditions from their students, although not always as radically different as now, and that these differences need to be seen and accepted. This does not mean that they discard their experience as excess baggage, but rather that its relevance to contemporary developments needs to be explained. Comparing older and newer forms, subjects, symbols, and ways of communicating these can surely be a profitable exercise for all concerned, bringing the generations of literate and electronic mankind closer together, and offering golden opportunities for meaningful reading, and training in observation, comparison, and generalization.

Conclusion

The tangible effects of the interaction between reading and technology include the many new ways in which information is visually presented or transmitted. The basic purposes of communicating, however, are much the same as when writing was invented: speculating about cause and effect, offering goods for sale, recording transactions, reporting new developments, scheming against common enemies, and keeping in touch with friends. Technological inventions, therefore, can be seen even today as extensions of human capacities and as brought about by human needs.

Changes in the forms of communication have not come about through a one-way cause and effect process. Technology did not always suddenly arrive on the scene and cause a change in thinking and reading patterns. It has often been the other way around: new ideas, and combinations of ideas, arrived at by human beings through reading and writing activities, created a climate or a need for new technology because new possibilities were envisaged. Basic to technological progress has been the concept, however commercially and politically corrupted, that individual human beings are capable of making decisions and do not need intermediaries to their God, or to be dictated to by autocratic rulers or paternalistic employers.

The intangible effects of the interaction between reading and technology are less clear. In the electronic age technology threatens to widen the gap between those who have access to political and economic power and those who do not. Those of us committed to helping people gain access by becoming proficient in processing information need to take into account its changing nature, different use of language, and the kinds of mental representations which will be needed for proper selection of stimuli. As William James said in 1890,

My experience is what I agree to attend to.
Only those items which I notice shape my
mind - without selective interest, experience
is an utter chaos. (Principles of Psychology, p.284-5)

Reading and Technology: Tangibles and Intangibles

A Highly Selective List of Interesting Events Related to Reading and Technology

- 1000 B.C. Phonetic spelling transmitted to the Greeks
350 B.C. All Greek states adopt the 24-letter alphabet
100 B.C. Alexandria Library reputed to hold 700,000 manuscripts
200 A.D. Ptolemy draws world map with latitude and longitude
700 A.D. Moorish invasion of Spain; Arabic numerals and algebra introduced in Europe
1190 A.D. Paper mills operating in France
1200 A.D. Compass known to be in use in many parts of the world
1325-50 Introduction of fire arms in Europe
1346 Division of hours and minutes into 60's

1440's Movable type invented; first use of standardized, interchangeable parts and assembly line operations
1456 Gutenberg Bible printed on 6 presses simultaneously

1500 Nearly 2,000 printing presses in Europe print 15-20 million volumes
- Books printed in the vernacular
- First pocket books printed in Venice
1504 Beginning of restrictions on printing in England
1517 Luther's theses posted in Wittenberg, disseminated all over Europe by 1525
1522 First arithmetic books printed in England
1530 Printing press established in Mexico
1565 Invention of lead pencils
1585 Decimal system developed
1588 Alphabet system of teaching reading through spelling known

1610 Galileo sees Jupiter through telescope he made
1614-20 Napier develops logarithmic tables
1650 Pascal writes about the laws of probability, uses calculating machine
- Beginning of scholarly journals

1702 Daily newspaper published in London
1725 Stereotype invented by Scottish goldsmith, William Ged
1731 Sextant invented by John Hadley
1783 Publication of Webster's Speller. 14 mill. copies sold by 1843
1796 Invention of lithograph process
- Paper made from pulp rather than rags

1814 The Times of London printed on the first flat-bed cylinder press powered by steam (1,100 impressions per hour)
1822 Niepce produced first photograph
1840's Mass publication of inexpensive books
1850 Engraving on metal by photographic means
1860's Colour printing process developed
1866 The Times printed on rotary press using both sides of continuous roll of paper (25,000 impressions per hour)

(Reading and Technology)

1870	Compulsory Education Act in England, 1872 in Scotland
1873-84	Development of telegraphy, the telephone, the phonograph, the typewriter, Waterman's fountain pen
	- Eye movements analyzed
	- Set theory developed by George Cantor
1879	Edison invents the light bulb
1885	Linotype patented
1890	Punched data cards used for U.S. census
1897	Influence of expectation on perception of words studied
1900-02	Automatic stereotype plates
	- Transmission of photographs by wire
	- Trans-Atlantic radio telephone (Herz, Marconi)
1903	Wright brothers flight
1905	Einstein's theory of relativity
1900-10	Rapid development of electron tubes
1927-29	Television used in a laboratory
	- Use of teletype
1940's	Development of different computers, calculators
1948	Development of transistor devices
1950	Librarians join mathematicians, psychologists, linguists etc. in documenting information processing procedures and uses
1956	Term "artificial intelligence" coined
1961	Russians launch space ship
1962	Post Office Communications station established to track satellites, transmit and receive signals
1970	Post Office publishes telephone directory printed by an integrated computer process
1979	Prestel, based in London, was the first public viewdata service
1969-81	Decisions against restrictions imposed by AT&T encouraged competition in communications industry

BIBLIOGRAPHY

- Binkley, M. A descriptive and comparative study of cohesive structure in text materials from differing academic disciplines. Unpublished dissertation, George Washington University, Washington, D.C., 1983.
- Bonn, T.L. Undercover: An Illustrated History of American Mass Market Paperbacks, Harmondsworth, England, Penguin, 1982
- Bruner, J.S. Growth of Mind. American Psychologist, 1965, 20, 1007-1017
- Bruner, J.S., Olver, R.R., & Greenfield, P.M. Studies in Cognitive Growth, New York, Wiley, 1966.
- Eisenstein, E.L. The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early-modern Europe, Volume 1. Cambridge University Press, 1979.
- Fuller, R.B. Critical Path, New York, St.Martin's, 1981.
- Gerhard, C. Meeting student need to understand structure in expository text. In D. Dennis (Ed), Reading: Meeting Children's Special Needs, London, Heinemann, 1984.
- Greeno, J.G. Trends in the theory of knowledge for problem solving. In D.T.Tuma & F. Reif (Eds) Problem Solving and Education: Issues in Teaching and Research, Hillsdale, N.J. Erlbaum, 1980.
- Huey, E.B. The Psychology and Pedagogy of Reading, Massachusetts Institute of Technology, 1968 (1908).
- Hurley, R.B. Decision Tables in Software Engineering, New York Van Nostrand, 1983.
- James, W. Principles of Psychology, New York, Holt, 1890.
- Kent, A. & Galvin, T. (Eds) Information Technology: Critical Choices for Library Decision-makers, New York, Marcel Edkker, 1982.
- Luckenback, S.A. (Ed) Probabilities, Problems, and Paradoxes: Readings in Inductive Logic, Belmont, California, 1972.
- Martlew, M. The Psychology of Written Language: Developmental and Educational Perspectives, New York, Wiley, 1983.
- McLuhan, M. The Gutenberg Galaxy: The Making of Typographical Man. University of Toronto, 1962.
- Mechler, A.M. Micropublishing: A History of Scholarly Micropublishing in American 1938-1980. Westport, Connecticut, Greenwood, 1982.
- Monaghan, E.J. A Common Heritage: Noal Webster's Blue-Back Speller, Hamden, Connecticut, Archon Books, 1983.
- Mukerji, C. From Graven Images: Patterns of Modern Materialism, New York, Columbia University, 1983.

- Nagel, E. Principles of the theory of probability, International Encyclopedia of Unified Science, 1955, 1, 343-422.
- Newell, A. Reasoning, problem solving, and decision processes: the problem space as a fundamental category. In R.S. Nickerson (Ed) Attention and Performance, Volume 3, Hillsdale, New Jersey, 1980.
- Olson, D.R. From utterance to text: the bias of language in speech and writing. Harvard Educational Review, 1977, 47, 257-281.
- Ong, W.J. Interfaces of the Word: Studies in the Evolution of Consciousness and Culture, Ithica, New York, Cornell, 1977.
- Pierce, J.R. Symbols, Signals, and Noise: The Nature and Process of Communication, New York, Harper, 1961.
- Ritchie, D. The Binary Brain: Artificial Intelligence in the Age of Electronics, Boston, Little, Brown Company, 1984.
- Schank, R. Reading and Understanding: Teaching from the Perspective of Artificial Intelligence, Hillsdale, New Jersey, Erlbaum, 1982.
- Scholz, T.W. (Ed) Decision Making Under Uncertainty, New York, North-Holland, 1983.
- Scribner, S. & Cole, M. The Psychology of Literacy, Cambridge, Massachusetts, Harvard University, 1981.
- Shannon, C.E. & Weaver, W. The Mathematical Theory of Communication, Urbana, Illinois, University of Illinois, 1964 (1949).
- Sloman, A. The Computer Revolution in Philosophy: Philosophy, Science, and Models of Mind, New Jersey, Humanities Press, 1978.
- Small, C. The Printed Word: An Instrument of Popularity, Aberdeen, Scotland, Aberdeen University, 1982.
- Smith, R.I. & Campbell, B. The Information Technology Revolution, England, Longman's, 1981.
- Stern, M.B. (Ed) Publishers for Mass Intertainment in Nineteenth Century America, Boston, Massachusetts, G.K. Hall, 1980.
- Stubbs, M. Language and Literacy: The Sociolinguistics of Reading and Writing, London, Routledge & Kegan Paul, 1980.
- Waldrop, M.M. Artificial Intelligence (I): Into the World, Science, February, 1984, 802-805.
- _____. The necessity of knowledge. Science, 1984, March, 1279-82.
- Winograd, T. Language as a Cognitive Process, Volume I, Syntax, Reading, Massachusetts, Addison-Wesley, 1983.